

ABSTRACT

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MILITARY HEALTH SYSTEM:
DESIGNING FOR POLYTRAUMA
WOUNDED WARRIORS.

Stephen Parker, Assoc. AIA

Master of Architecture

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Directed by:

Professor Garth Rockcastle, FAIA

School of Architecture, Planning &

Preservation

As an agent of healing, architecture can provide a restorative environment for polytrauma patients and their families. A new model, this polytrauma treatment and training center synthesizes *evidence-based design, translational medicine and family-centered care* to design an environment that improves health outcomes for our **wounded warriors**.

MILITARY HEALTH SYSTEM:

DESIGNING FOR

POLYTRAUMA

WOUNDED WARRIORS

By

Stephen Nickolas Parker

Thesis submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
of the requirements for the degree of
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Advisory Committee:

Professor Madlen Simon, AIA, Chair

Professor Garth Rockcastle, FAIA

Professor Jason Winters, AI

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Preface

I began this process over a year ago but started dwelling on healthcare design long before. For me, this was an exploration into an area of architecture whose complex nature deters many. As well, it was an opportunity to help those that have sacrificed so much to protect our nation. By designing a better healing environment for the most traumatized wounded warriors, I can, in some small way, serve those that serve us.

Dedication

I wish to dedicate this work to our service men and women but also to the members of my family that have served our country in the armed forces, namely my grandfather Marshall Wells, who served through three wars and my namesake, my uncle Steve Taylor who served in Vietnam. These scars of those experiences they would bare with them, physically and otherwise, for the rest of their lives.

Acknowledgements

There were numerous contributors to my thesis research. Of course the support of my thesis committee, Mady Simon, Garth Rockcastle and Jason Winters was invaluable to keep my progress on track. As well, the whole of my thesis class created a supportive environment and encourage one another throughout the year. As well, from the professional world, the advise of Brian Sykes of HDR, Shannon Kraus of HKS as well as Brenna Costello & Julia Phillips from SmithGroupJJR were insightful and encouraging. In addition, interviews with Bob Salas of HOK and Jose Silva of CannonDesign were very helpful in guiding my research. In addition, all of the nurses, administrators and doctors I talked to was inspiring and enlightening, especially on how the healthcare system heals our wounded warriors. And the support of my wife, Carrie Lee Parker, was essential.

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Thesis Statement

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Thesis Abstract

Problem: The road to recovery can be a long and trying ordeal for polytrauma patients in the Military Health System. Current military hospitals rarely offer both the right expertise and the right facilities in the same place, requiring polytrauma patients to crisscross the country, thereby delaying recovery from their life-threatening injuries.

Motivation: Architects can serve our country by designing polytrauma facilities to better serve our wounded warriors.

Approach: The thesis applies research in evidence-based design and translational medicine to the design of a state-of-the-art polytrauma facility for a site on the campus of Walter Reade Medical Center. The three goals are: 1. Improve outcomes for polytrauma patients, 2. Support visiting family members, 3. Foster education of polytrauma physicians.

Results: The resulting design serves as a test for translating medical concepts into architectural form on a real site.

Impact: The thesis offers lessons for architects designing military polytrauma facilities, demonstrates to physicians how polytrauma facilities can be designed to serve their needs, and serves as a test case for future polytrauma facilities to be commissioned by the armed services.

Imperative

The current military health system is a vast network of 65 hospitals, 825 clinics and serves nearly 9.6 million beneficiaries. Its \$50 billion budget includes a number of new facilities to replace its aging infrastructure. These new replacement facilities will have to meet the unique needs of the armed services. In the past decade, this includes dealing with increasing numbers of post-traumatic stress disorder (PTSD) cases (100,000+), amputees (1700+) and improvised explosive device (IED) survivors¹. Given these challenges and their myriad relationships to one another, it has vast design potential. Looking back at how this thesis topic developed, it was the appeal of healthcare's complex considerations requiring designers to dig deeper and explore more widely the possibilities of improving the treatment settings for them that attracted me. It was akin to the ultimate design puzzle. The number of forces to contend with, the range of stakeholders and regulatory conditions while still maintaining design integrity was alluring. As well, my recent studio project, an ageing-in-place community in Connecticut, used many lessons learned from the Wounded Warriors Housing Project in Ft. Belvoir. The visceral nature of the injuries inflicted upon our service men and women struck a

¹ 2012 DOD Casualty Report

cord with me. These considerations focused my attention to the opportunities available in the realm of healthcare design. It's my hope that in my research and design approach, architecture can advocate for their healing, give voice to their suffering and ensure these wounded warriors be treated with the dignity and care they deserve.

Approach/Perspective

Question

How do we take care of our wounded warriors, with 80% of our returning soldiers having some sort of physical, life-altering condition²? This is a question of our time that needs better answers. If an architect can generate a design to help overcome the condition of our wounded warriors, then architecture can be an agent of healing. One aspect of an architect's true value and relevancy in society is proposing a vision and solution that has yet to become reality. Tying together the multiple stakeholder narratives of a healing environment, doctors, nurses, administrators, families and patients, into a coherent architectural space is one of the lasting contributions of architects upon the fabric of society.

² Statistics courtesy of Wounded Warrior Project

The Investigation

To explore these ideas, I investigate relevant projects, literature and architects doing the most recent work in the realm of healthcare design. But the most up-to-date knowledge resides in professionals working in the field today. Relying on the expertise of healthcare architects from such firms as HKS, HOK, SmithGroupJJR, AECOM, Cannon Design and HDR will help guide research and help inform my design focus. Examining a myriad of military medical projects and distilling relevant design principles will give traction to the design process. In addition, gaining the perspective of stakeholders, the doctors, nurses, administrators, families and patients will add to the depth of meaning required of a thesis, especially for an issue so pertinent and complex

Perceived Results

The results of such research could uncover an area of need in the Military Health System. This will help synthesize current best practices in the field for ease of understanding. For the area of surgical and diagnostic program, this includes highlighting instances where efficiencies can occur, especially by infusing progressive technology and design strategies. As well, where program synergies can be identified, such as, such as the use of progressive diagnostic equipment that is shared with surgical suites. The culmination of these results can be both enlightening and uplifting for

wounded warriors progressing through the most arduous portion of their recovery.

Expected Impact

This research will help identify and hopefully address an area of need. For the purposes of the thesis design studio, this research will focus on an existing military base that currently caters to a population of service men and women in need of such specialized care. This is likely in a suburban setting, not an urban one, given that most military installations are located in less densely populated areas. It will most likely fit onto an existing medical campus or perhaps incorporated in a new, larger facility as a new ward or wing. Such a new type of facility will be a place of healing that provides the best possible care to our armed services as they make the transition back to civilian life or a possible return to service. As well, it will hopefully create a model that can be adapted wherever it is needed throughout the vast U.S. Military Health System.

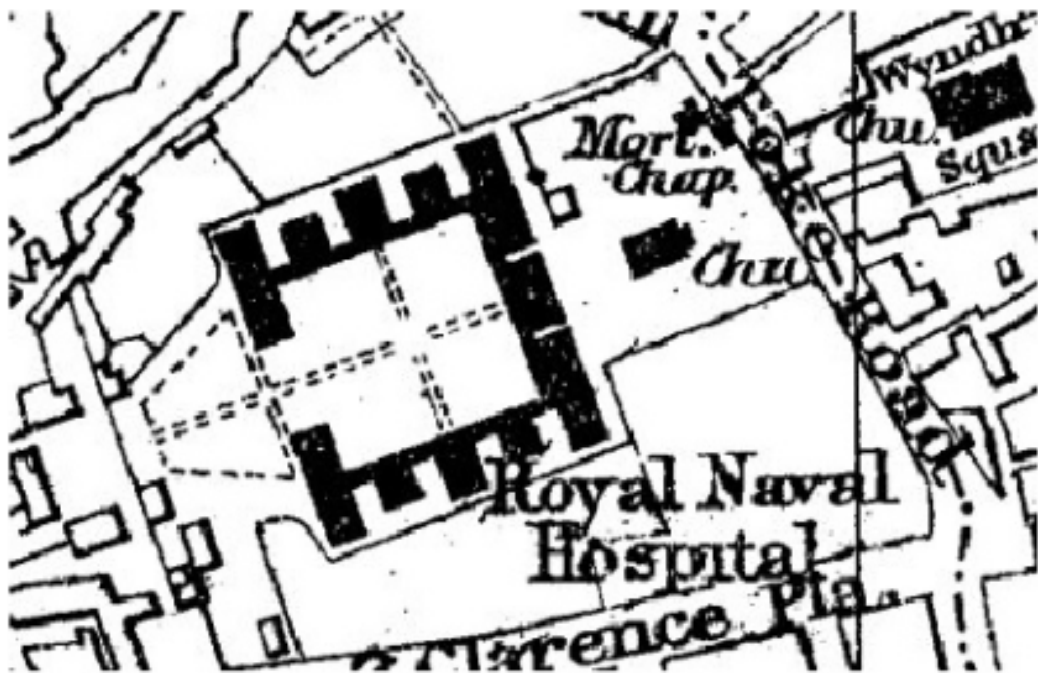
History of Military Hospitals

To give the issue of military healthcare facilities some context, a brief history of this unique typology is helpful. Beginning with the Greek *asklepeion*, which was derived from the *stoa*, the central element of Greek towns and cities, this was the first recorded place of healing. The Romans adapted the *asklepeion* and developed their *valetudinarium* or military hospital. This integral part of the Roman military fort, or *castrum*, was located adjacent to the Via Principalis, the main thoroughfare of the Roman fort.



Perspective of Kos' asklepeion. (Courtesy of DoD)

Throughout the Middle Ages hospitals were centered in abbeys, monasteries and other religious institutions. Around the 14th century, city-sponsored hospitals became prominent, beginning in Italy but all were adapted forms. It wasn't until King Louis XIV of France established the government hospitals that incorporated the needs of convalescents, incurables and invalids. It wasn't until the British created the pavilion plan, shown below as the Plymouth Royal Naval Hospital in 1760. This was a series of wards organized around an arcade surrounding a courtyard.



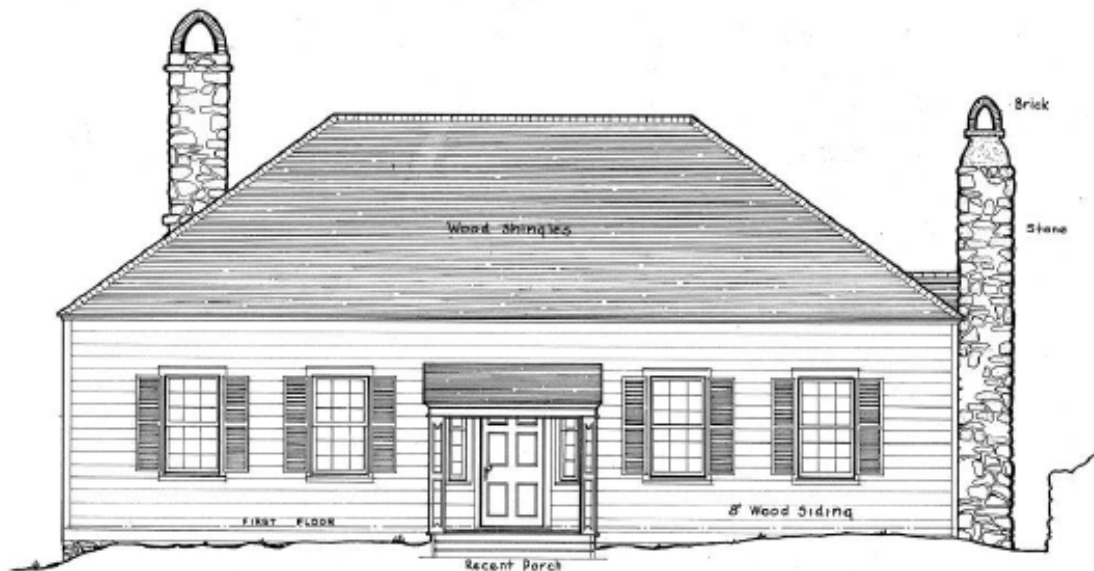
Royal Naval Hospital, 1760, Plymouth, MA (Courtesy of DoD)

Benjamin Franklin and Thomas Bond founded the first hospital in the US. The Pennsylvania Hospital in Philadelphia housed a ward in each floor, one of the first vertically oriented hospitals. But the father of the US military hospital is James Tilton of Delaware. His experiment with small, well-ventilated log cabins was the first successful attempt at designing spaces specifically for wounded warriors. Ventilation was an area of emphasis that became a critical component of healing spaces for ages to come. This necessity led to the development of air filtration in modern hospitals.



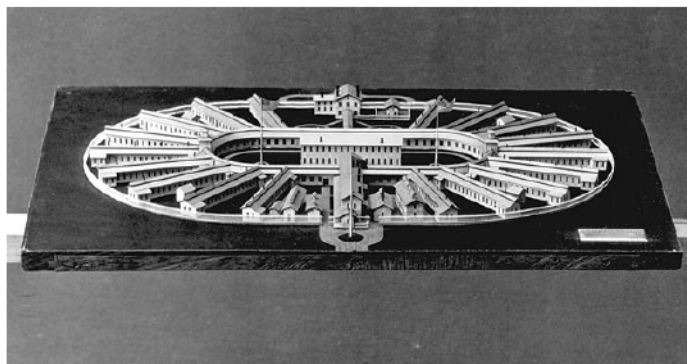
Tilton's Hospital concept (Courtesy DoD)

Pre-Civil War military hospitals were characterized by further adapting existing residential structures and replicating those forms as needed, especially out in the frontier forts of the American West. Military bases on the Eastern Seaboard started generating hospitals that shared similar amenities and design elements, such as verandas and porches to increase the patients' connection to the outdoors. Many were square plans of various sizes, sometimes with wings containing wards projected on the sides. It wasn't until the impetus of the Civil War that military hospital design took the next leap forward.



Fort Mackinac, Michigan (Courtesy of DoD)

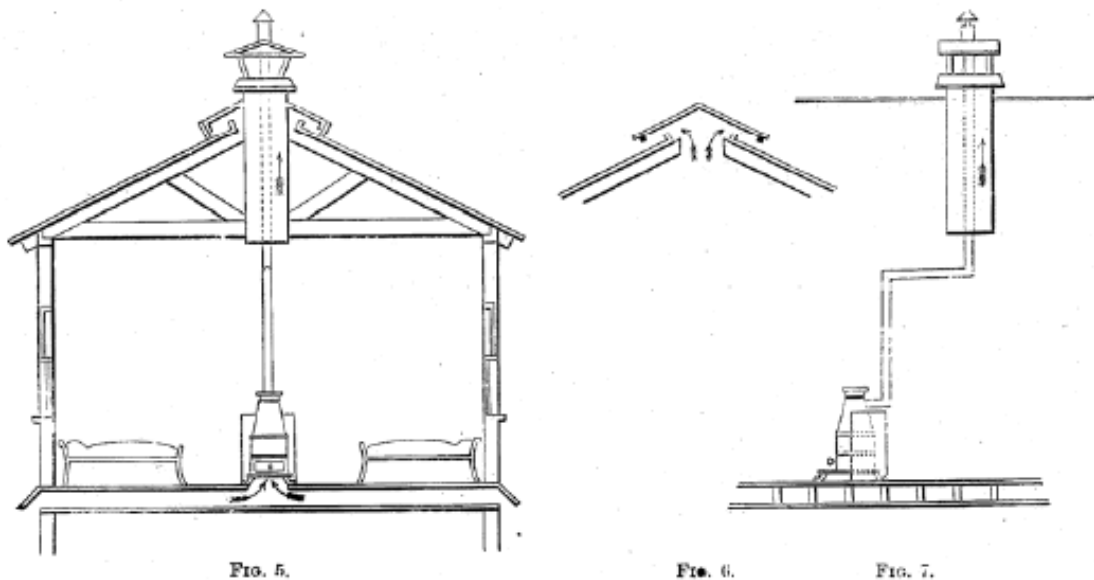
With the onset of the Civil War and the implication of caring for tens of thousands of wounded soldiers at time had a profound effect on the scale of military hospitals. Instead of beds for 20 or 50 or a 100 patients at a time a thousand sick or injured soldiers had to be cared for. Long pavilions, sometimes no more than fifteen feet wide housed patient beds on either side, connected by a central path through the middle of the pavilion. Larger and longer pavilions became organized in increasingly complex arrangements, usually around a central administration building. One of the first was the Armory Square Hospital outside D.C. or McClellan General Hospital in Philadelphia. These new hospitals connected their long, narrow pavilions with enclosed walkways. Unfortunately, these took up vast swaths of land, an issue that military hospitals are still grappling with today, especially on the densely packed East Coast.



McClellan General Hospital, Philadelphia, Pennsylvania.

(Courtesy of DoD)

Post Civil War hospitals shared one aspect with Benjamin Franklin's first hospital: verticality. Many rose multiple floors, with wards on each levels and were much smaller than those required to deal with the overflow caused by the Civil War. Form was based on the Surgeon General Circulars, design guidelines issued to help guide the design and construction. This included ventilation and heating diagrams for a typical ward, among other details designed to aid patient health. If it was too cold, patients couldn't get comfortable, too hot and they couldn't sleep. Thermal comfort and control is was a recurring theme.



Ventilation drawings from Surgeon Generals Circular #10

(Courtesy of DoD)

The next leap in military hospital design occurred in the succession of wars in the first half of the 20th century. Between the shorter WWI era expansion and the more prolonged years of conflict surrounding WWII, military hospitals expanded beyond the general hospitals located in San Francisco and Washington, DC. They were characterized as being much more grand, vertical and dense. Cold War-era thinking only reinforced that idea, with larger and more complex structures intended to deal with a large wounded population from a conflict with the Soviet Union, most likely in Europe.

After the fall of the Berlin wall and the threat of Soviet aggression far gone, the dismantling of this vast system saw many hospitals shuttered, sold or transferred to the Veterans Administration by the Base Realignment and Closure Program (BRAC). In the past decade or so, this has resulted in consolidated military medical campuses and more robust replacement health facilities.

Scope of Thesis

Military Health System:

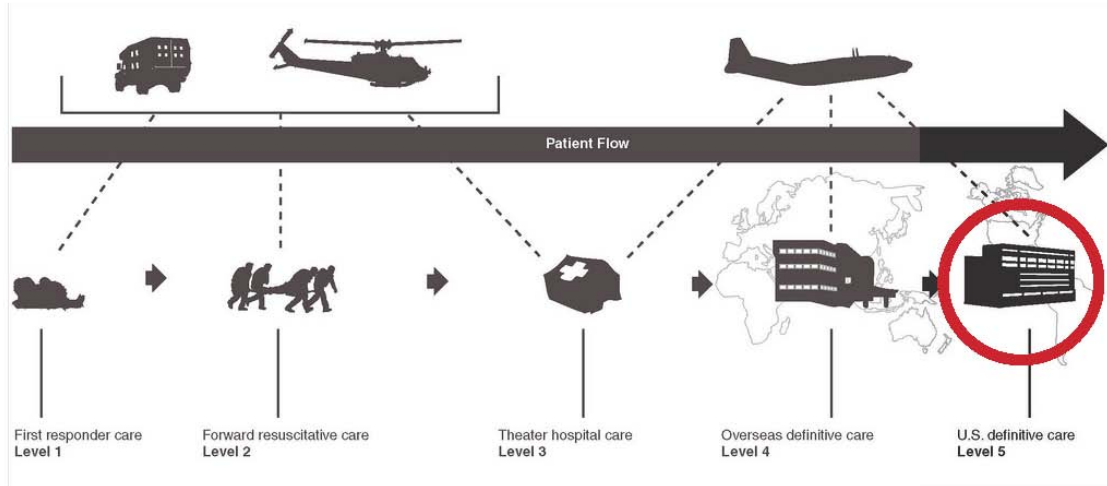
From Iraq/Afghanistan to Landstuhl, Germany to the U.S.



For the purposes of this thesis, concentrating on military medical facilities within the US seemed most prudent. Typically the path of wounded warriors includes stabilization in the field and definitive care, either abroad or in the US. For the soldiers serving abroad in Afghanistan and Iraq, this usually means a stopover in Landstuhl, Germany, where the U.S. Military has established a large medical complex since WWII. This patient path highlights the geographic scale of care required for some wounded warriors.

Military Health System:

Focus on Level 5 - U.S. Definitive Care



To further narrow the focus of this thesis, concentrating on Level 5 of the U.S. Military Health System, which includes Definitive Care within the U.S., seemed be the most germane area of interest. Especially since 4 primary VA Polytrauma Centers have been established in Richmond, VA, Tampa, FL, Minneapolis, MN and Palo Alto, CA with 18 supporting satellite facilities throughout the United States.

Patient **Levels:**

Level 0-

Patients whose needs can be met through normal ward care in an acute hospital.

Level 1-

Patients at risk of their condition deteriorating, or those recently relocated from higher levels of care, whose needs can be met on an acute ward with additional advice and support from the critical care team.



x5 Patients

Level 2-

Patients requiring more detailed observation or intervention including support for a single failing organ system or post-operative care and those 'stepping down' from higher levels of care.



x3 Patients

Level 3-

Patients requiring advanced respiratory support alone or basic respiratory support together with support of at least two organ systems. This level includes all complex patients requiring support for multi-organ failure.



x2 Patients

For wounded warriors classified as polytrauma patients, this means certain staffing ratios, as evidenced in the diagram above. While a polytrauma patient might be stabilized in the field, transported to Definitive Care facility abroad and finally transferred back to the U.S. for final treatment, their acuity level might fluctuate. This could mean being ambulatory one day and bedridden the next, since they might have to endure multiple surgeries over an extended period of time. Between each surgery they might have to endure rehabilitation to satisfy their doctors that their bodies can handle another round of invasive surgical procedures.

Hospital Trauma **Levels:**

Level 1 Trauma Center-

Highest Level, has a full range of specialist and equipment available 24/7.

Level 2 Trauma Center-

Compliments a Level 1 hospital and provides essential specialties 24/7.

Level 3 Trauma Center-

Has emergency resuscitation, surgery, and intensive care capability for most trauma patients.

Level 4 Trauma Center-

Provides initial evaluation, stabilization, diagnostic capabilities, and transfer to a higher level of care.

Level 5 Trauma Center-

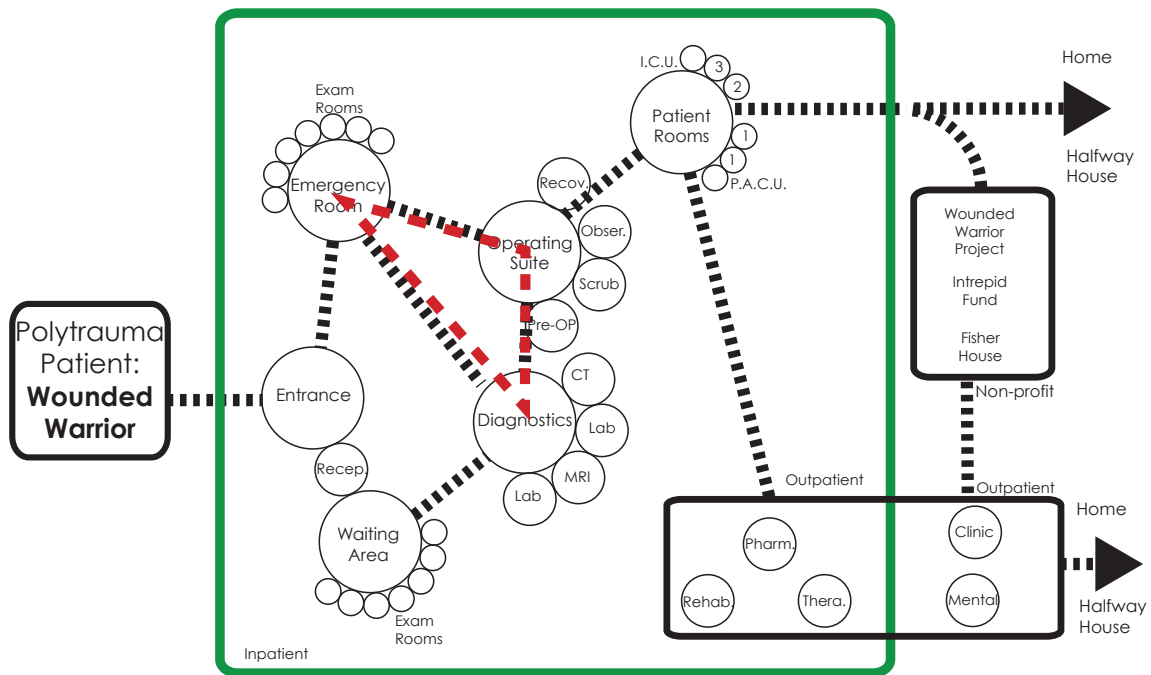
May provide surgical and critical-care services, as defined in the service's scope of trauma-care services and may not be open 24 hours a day.



(Courtesy of HDRinc.com and smithgroupjjr.com)

As well, with the most traumatic components of Definitive Care occurring in the surgical and diagnostic areas, these two program types deal with the most grievously injured of wounded warriors, polytrauma patients. Polytrauma patients have to contend with numerous, compounded injuries. Exploring more efficient, effective and humanizing ways of restoring their health in this “triangle” provided the most fertile grounds to explore a healthcare design thesis. That dichotomy, of surgical and diagnostic departments, is closely associated in hospitals, especially Trauma Level 1 and 2 facilities.

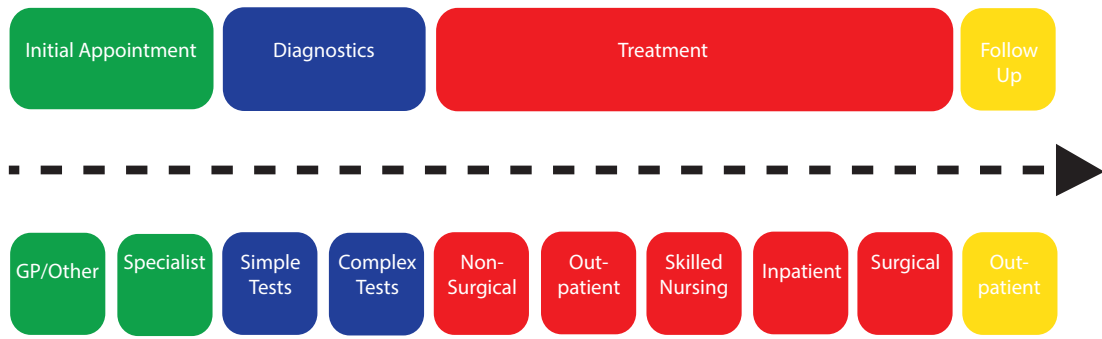
U.S. Military Health System



Surgical +Diagnostics

Diagnostics provides the needed data and insight into a patient's condition, which drives the response for surgical intervention. From diagnosis to treatment, this is one of the most crucial aspects of the patient pathway, especially polytrauma patients. That relationship is critical for the function of a hospital and can be made more safe, effective and humanizing.

Patient **Pathway**



Stakeholder Perspectives



(Courtesy of Fox.com)

Doctors:

In the pecking order of the hospital, the doctor typically has the final say on the patients' health, aside from the patients themselves. Their higher standing in the hierarchy might give them more power but their contact time with patients is more limited, since they are typically responsible for more patients than nurses are. They might have their own office and be further isolated from the patients except for examination or operating rooms, depending on their specialty. This is not to say that all doctors fit the stereotypes (God complex, etc.) society may place on

them. One doctor I've been in contact with, Dr. Craig Kolk, is a very passionate individual. A cosmetic surgeon that rotates through Walter Reed National Military Medical Center (WRNMMC) in Bethesda, Maryland, Dr. Kolk's unique skill set requires him to intimately study a patient's original body before they were scarred, or in many cases, had limbs amputated. IED survivors have an especially haunting pattern of wounds that he has become familiar with and therefore works on large number of such patients with these injuries, given his specialty. His time is therefore spent studying their charts, working with the operating staff, prepping for the procedure, operating on the patient, and tracking their recovery. Much of those activities are done without patient contact.

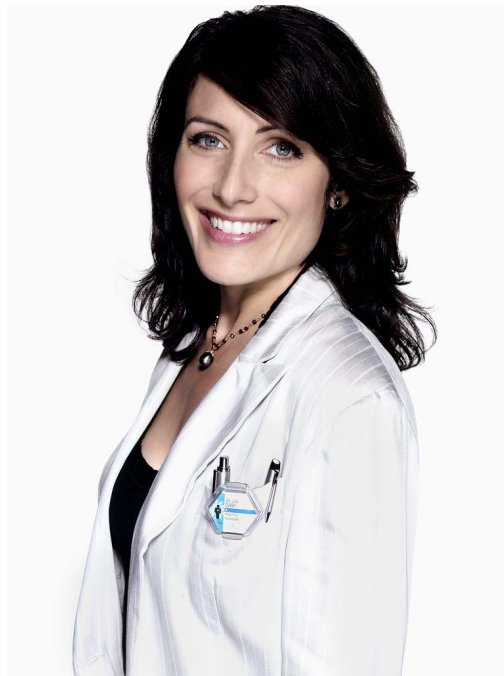


(Courtesy of ABC.go.com)

Nurses:

As the principle caregiver to the patient, they have a profound influence. In a military hospital setting, civilian or uniformed personnel might be nurses, depending on specialty, location and so on. For nurses, who typically operate on 12-hour shifts for a certain number of days per week, shifts change depending on the patient type. Rachel Zink, R.N. is a nurse at George Washington University Hospital in downtown Washington, D.C. She works in an existing complex of buildings set in a dense urban setting and contends with different healthcare settings as a result. For example, an older bed tower with centralized nursing stations sets up a different aspect of care than one with decentralized nursing stations distributed closer to patient rooms. Centralized nursing stations

concentrate the staff in one area, making response times longer given the increased distance. Decentralized nursing stations providing closer contact with patients means nurses can respond faster, observe patient progress better and make developing a relationship with the patient easier. As well, nurses are in charge of observation and whatever daily treatment the patient is required to receive. Depending on their specialty, they could also be assisting in surgical operations, patient testing, imaging or other duties and have interactions with a variety of personnel.



(Courtesy of Fox.com)

Administrators:

At the height of the hospital hierarchy, administrators view the inner workings of their domain quite differently than nurses or doctors might. Often doctors themselves, military hospital administrators are officers as well. In charge of budget, scheduling, facility management and so on, they carry the greatest impact in terms of facility decisions. As part of the larger bureaucracy of the Military Health System and their particular branch of the armed services, they function within a far larger system than a private hospital administrator normally would.



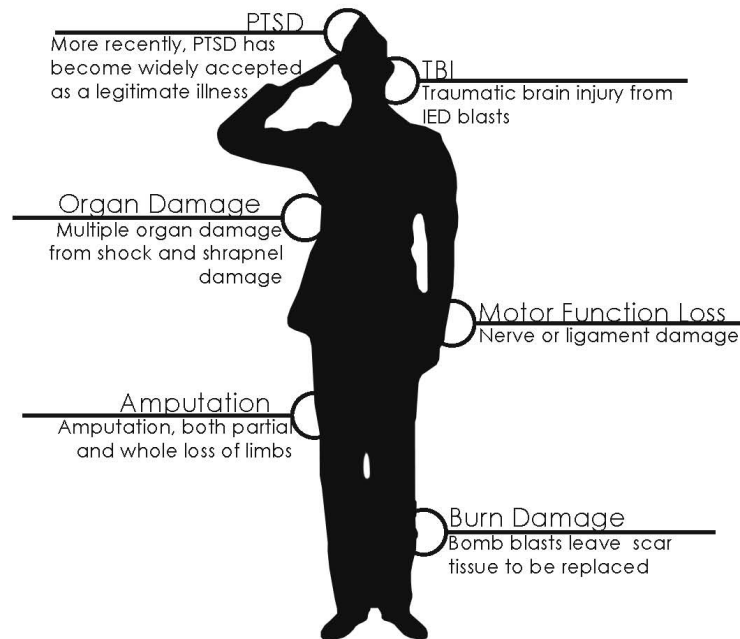
(Courtesy of soldiersangels.org)

Families:

For families, hospitals can be intimidating places. Worried about a loved one and typically thrust into an unfamiliar situation, families have enough stress to contend with without becoming lost or unduly stressed by their environment. Stress is key here, just as it is with patients. That's why many new hospitals are incorporating small seating clusters for families to congregate around, dedicating family rooms or semi-private alcoves. As well, third party non-profit organizations provide free family housing located nearby, such as Fisher Foundation Houses. Families can be a powerful aid in the healing process, as highlighted by the Planetree Alliance model³, with abundant art, easy way-finding features and other amenities can help lessen the institutional feel of the facility.

³ Gaeta, M., Gilpin, L., Arneill, B. P., Nuelsen, P. H., and Frasca-Beaulieu, K. 2000

Polytrauma Patients



*Polytrauma Patients: **The Wounded Warrior:***

Patients or wounded warriors are the focus of the hospital mission. For many of these returning soldiers, it's a vastly different setting than they are used to in the realm of combat. Be it amputee patients dealing with the loss of a limb to cases of PTSD, making reentry into civilian life that much more difficult, each soldier, sailor or marine deals with their injury differently. Some may be bed ridden for an extended period of time and not be able to exercise regularly with their unit, as they've become accustomed to. Others may need more time to themselves to deal with

their situation individually away from others, especially if they find their injury shameful. Giving them options can help them regain their sense of dignity and control over their lives, improving their healing process.

Vision

The vision of this thesis responds to the assertion outlined in the abstract, which includes improving the health, dignity and welfare of wounded warriors. First, we must ensure the *health* recovery of wounded warriors, especially the most grievously injured polytrauma patients. Second, these injured servicemen and women must be allowed to regain their *dignity* after losing a portion of themselves, physical or otherwise, in service to their country. Lastly, we must advocate for the continued *welfare* of wounded warriors, now and into the future, by transforming the most critical capabilities of Military Health System (MHS).

Values

The responsibility of the architect is to derive architectural form in a sustainable manner for the benefit of the public health, safety and welfare. It is from this trajectory of thought that there are a number of values that are the emphasis of this thesis. One is the design of *healing spaces*. The second is the ensuring public safety through a *sustainable design* of the built environment. And the final driver of this thesis is to advocate for the welfare of our **wounded warriors**.

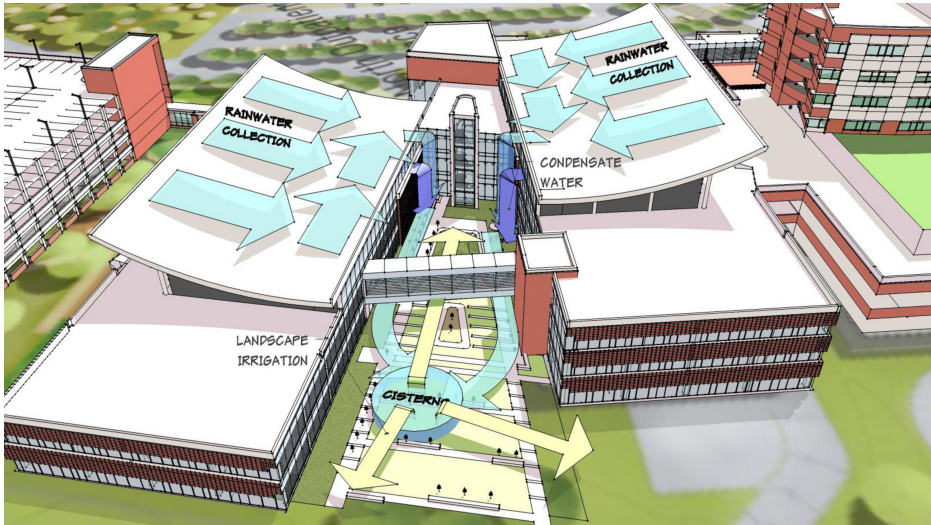
Healing Places/Healing Spaces:



(Courtesy of Kaiser Permanente)

The emphasis of a hospital should be a place of wellness, healing, and recuperation. In this way, a hospital can be more than just a place for acute care needs of patients. This includes ample space for families and visitors, which enhances the mental as well as physical component of the healing process. This includes reducing stress from an unfamiliar and clinical environment, pain from repeated surgeries and occupational therapy, and combating depression from long hospital stays and the loss of one's independence.

Sustaining patient health, facility effectiveness & community:



(Courtesy of militarytimes.org)

Creating healing spaces that sustain the health of the patients as well as the building itself is a consideration of this thesis. One of the underlying reasons that a military hospital close, besides BRAC guidelines, is that do not take innovation in stride. The creation of a comprehensively designed hospital takes into account water usage, energy production/consumption, ease of maintenance and flexibility for expansion and innovation. This could result in the creation of a chassis or modular system. In addition, military medical facilities are usually located on post and serve a community of servicemen and women, as well as their families. If hospitals are to be an active participant in the health and wellness of communities, integrating these large, imposing buildings into their communities could be the basis for an entire thesis but it is a consideration nonetheless.

Specificity for Wounded Warriors:

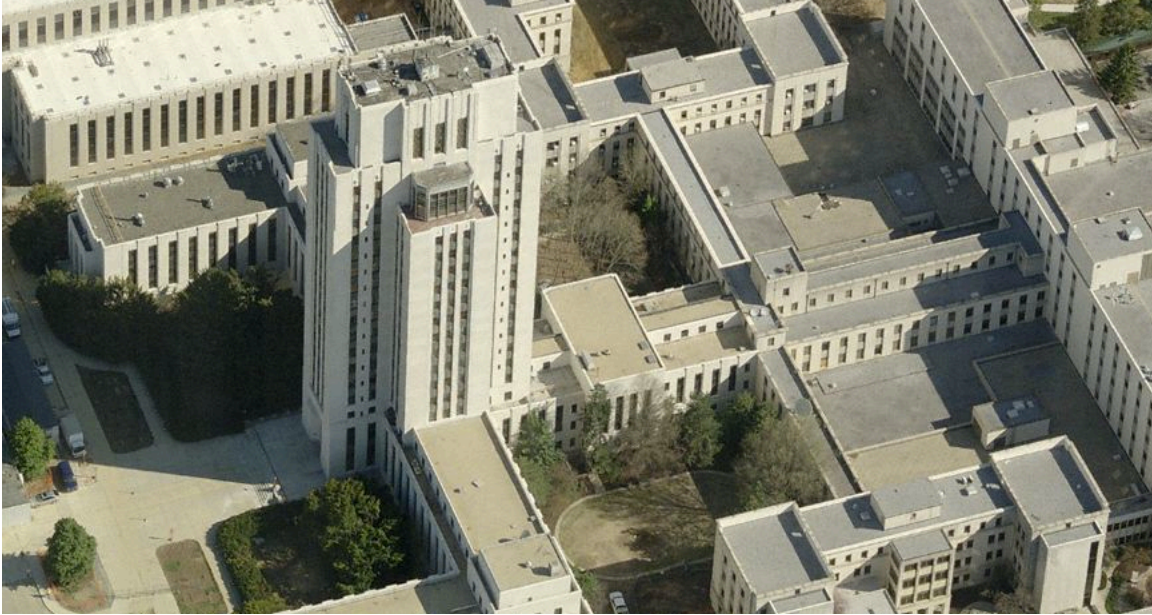


(Courtesy of woundedwarriorproject.org)

It is imperative that an emphasis is placed on security and tranquility for the peace of mind of wounded warriors, creating a healing environment that is the antithesis of the combat zone. These areas of emphasis will help focus my thesis, especially for current areas of interest that haven't been adequately addressed by the profession as of yet. For example, Americans with Disabilities Act (ADA) requirements don't also accommodate wounded warriors, especially amputees who easily topple over. Addressing such specific issues help to narrow the scope of work for the thesis design studio.

Case Studies:

The Walter Reed National Military Medical Center, Bethesda, MD



(Courtesy of HOK.com)

The Walter Reed Army Medical Center (WRAMC) and its successor, the Walter Reed National Military Medical Center (WRNMMC, formerly the Bethesda Naval Hospital) is a good case study in three parts. The first is its role as poster child for military reform, given that it's an outdated facility that carries a negative connotation. Secondly, its evolution as a hybrid facility that's shared between various armed services. Lastly, it highlights an existing site with historic structures that expanded to meet the military's needs. For this campus, spatial orientation and way finding for visitors is very problematic, given the various additions that have occurred over the years.

Ft. Belvoir Community Hospital, Fort Belvoir, VA



(Courtesy of HDRinc.com)

Ft. Belvoir has become the prime example of evidence-based design for military healthcare. Designed around a series of “pavilions” themed after nature, it includes 1.27 million square feet of space, an family-oriented outpatient center, an outpatient center for specialty care and a central inpatient tower. Its emphasis on patient/family-oriented environments is an important driver in the design. Spreading out from a 7-story, Level 1 Trauma center are four clinic buildings. Each clinic has waiting and reception at one end (with full-height windows), offices to the rear, and interchangeable offices and exam rooms in the center. This concept is repeated dozens of times throughout the buildings, allowing future programs to expand or contract as needed.

Ft. Bliss, El Paso, TX



(Courtesy of HDRinc.com)

This new replacement hospital, is one of many under construction or recently completed throughout the country. This \$1 billion dollar project has an interesting research approach, with the Army Corp of Engineers commissioning HDR to develop alternative building technologies that can be deployed throughout the MHS and the larger healthcare industry. This included a new HEPA filter and UV-based cleaning process that has resulted in a high-yield return now that the technology has been patented. The emphasis on air quality and sanitation are important aspects of any hospital design and this case study highlights innovations that will have a significant impact on medical building technologies.

National Intrepid Center of Excellence, Bethesda, MD



(Courtesy of SmithGroupJJR.com)

As part of the Fallen Heroes Intrepid Fund, a series of rehabilitation and diagnostic facilities have been funded and built to fill a gap in the services provided by the MHS. These facilities have been handed over to the DOD to fill in these areas of need. They primarily contend with the diagnosis of Traumatic Brain Injury (TBI) patients and the rehabilitation of amputees, two injury types commonly associated with polytrauma patients. It's emphasis on reducing stress and pain in patients is one it's primary design drivers.

Interviews:

Brian Sykes, AIA of HDR

Since HDR, a large, employee-owned architecture & engineering firm. Brian Sykes, one of their senior healthcare design. His knowledge on the constructability and design of large healthcare facilities was an enlightening influence on my thesis process. From sharing material on current projects, noting common rules of thumb and best practices very beneficial. As well, the recommendation to research one of three emerging typologies was extremely informative. These three typologies included a long-term family-centered care inpatient facility, an amputee rehab center and blended surgical/diagnostic operating suites.

A long-term family-centered inpatient building is simply an inpatient facility, where patients are housed over night but are designed to accommodate visiting family. Patient rooms that have extra seating, a spare bed and the room for loved ones to stay more than a few hours to help their loved one through this difficult process.

Another typology, an amputee rehab center, was also suggested. These facilities have become increasingly common in the VA Health System, as many amputee veterans require long-term care and rehabilitation. This is true of both the new Intrepid Center in San Antonio, TX as well as various Polytrauma Clinic in the VA Health System. For recent amputees, who number in the thousands since the recent Middle East

wars, the experience of losing a limb is already a horrific ordeal.

Contending with a lifetime of limited mobility is another level of discomfort that is ever present day to day. Retraining their bodies and minds to accomplish even the simplest tasks is time consuming. Regaining confidence and dignity have to be integral to the design process.

The third typology is blended operating suites that include diagnostic equipment in the surgical space. This is becoming, regrettably, more common, especially given the complex wounds inflicted in today's war zones. The integration of MRIs and CTs in operating rooms, especially to treat complex wounds throughout the body, such as missing shrapnel, multiple organ damage and head trauma, among others.

Shannon Kraus, FAIA of HKS

Shannon Kraus is a Vice President at HKS Architects and heads their DC office. Their expertise in healthcare design is well known and highly regarded. This includes being the design architect of the latest expansion of the Walter Reed National Military Medical Center. My interview with Shannon gave me an initial introduction to the current trends in the field. This included questions on how to design for future needs and how large hospital complexes evolve over the years. They can evolve over nearly a hundreds years since they were established, making them a distorting experience for visitors.

In addition, there are a number of new ideas in healthcare design at the moment. One that was discussed was Lean-led Design, also called Six Sigma or the Toyota Method. The idea behind “lean” is that you continually refine your process or product. Toyota developed this method to create a more efficient car production approach and at their scale, it was quite effective. For healthcare facilities, as well as any typology, the idea is to really exam what you’re trying to accomplish in regards to the program. In a hospital, the layout of a nursing station is a good example. By calculating the number of steps a nurse would take to gather linens and bring them to a patient has a profound impact on their ability to operate effectively over a 12-hour shift. In the same manner, by examining, in detail and with quantitative as well as qualitative analysis, efficiencies can be found and implement. A critical aspect of the lean-led process is engagement with stakeholders up front and creating mock-up of critical spaces, enacting their activities upon a space.

Bob Salas, AIA of HOK

Bob Salas is an architect and project manager with HOK. His experience in healthcare design, and especially my site, Walter Reed Bethesda, as project manager of its latest expansion, which finished in 2011. My interview covered a number of topics, including how amputees require designing well beyond ADA standards. Many with leg injuries have a shifted center of gravity and can no longer do simple tasks, such as lift

themselves onto a bench. When redesigning a space for someone without legs or an arm, normal handrail heights just don't work.

Brenna Costello, AIA and Julia Phillips, AIA of SmithGroup JJR

Both Mrs. Costello and Mrs. Phillips were on the design team of a key precedent, the National Intrepid Center of Excellence or NICoE at Walter Reed Bethesda. It is a flagship facility that addresses Traumatic Brain Injuries or TBI that has become increasingly common in the past decade. This research center, at 72,000 SF will act as test bed for new TBI treatments and be implemented through a new network of TBI centers on military medical campus around the country. Both architects spoke of the need to really delve into what experiences these soldiers have endured and their need to regain their sense of self-identity and dignity. For soldiers that relied upon their squad mates for support and in turn supported them, the isolation of being in the gears of the vast MHS system is daunting. The inability to know function as they once did nor have an objective or mission can have dramatic effects upon their emotional state. Compounded with the brain injuries that occur with TBI patients, the healing process can be quite an ordeal.

Healthcare Design Principles

Translational Medicine:

design research



Bringing educators and practitioners together to **share knowledge**.

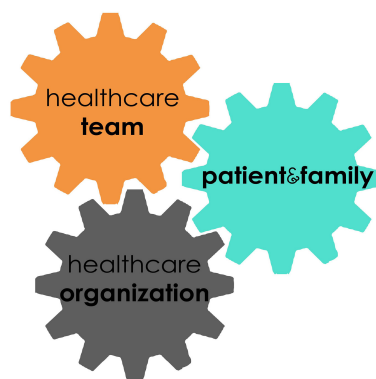
In the same manner, students can **spontaneously interact** with practitioners.

Innovating and disseminating best practices for treating polytrauma patients to the **next generation of military doctors**.

Translational Medicine

Family-Centered Care:

design research



By bringing in a patient's family into the **decision-making process** and the recovery of their loved ones, health outcomes can be greatly improved.

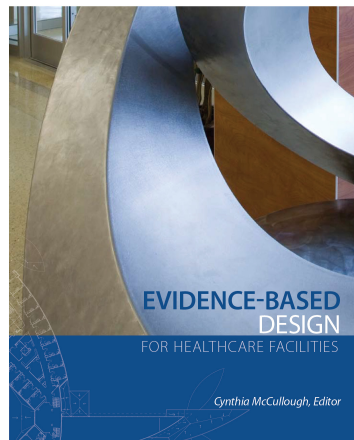
This is not just during major medical intervention but also the **family involvement** during the recovery period that most polytrauma patients endure.

Family-centered Care

Evidence-Based Design:

This approach originated in the medical field and permeates many other professions, including architecture. Its basic principles are that all practical decisions made should 1) be based on research studies and 2) that these research studies are selected and interpreted according to some specific norms characteristic for Evidence-Based Practice. For healthcare design, this means learning what possible impacts a design decision can make. For example, if views of nature have been found to improve health outcomes, then that principle is incorporated into the design process. It's a system favored by the Military Health System.

design research



MHS adopted Evidence-Based Design principles

Principle 1: Create a Patient-and Family-Centered environment

Principle 2: Improve the Quality and Safety of Healthcare

Principle 3: Enhance Care of the Whole Person by Providing Contact with Nature and Positive Distractions

Principle 4: Create a Positive Work Environment

Principle 5: Design for Maximum Standardization, Future Flexibility, and Growth

Evidence-based Design

EBD Principles adopted by Military Health System:

For the purposes of my thesis research, I used some aspects of Evidence-Based Design to gain traction in this very specialized field, especially since the Military Health System has adopted such principles in new facilities.

Principle 1: Create a Patient- and Family-Centered Environment

Principle 2: Improve the Quality and Safety of Healthcare

Principle 3: Enhance Care of the Whole Person by Providing Contact with Nature and Positive Distractions

Principle 4: Create a Positive Work Environment

Principle 5: Design for Maximum Standardization, Future Flexibility, and Growth

Through this framework the evidenced-based design strategies that best impact the relationship of surgical and diagnostic departments can be evaluated.

Relevant Evidence-Based Design Principles for

Diagnostic/Surgical Suites

There are numerous categories of knowledge that have proven benefits for healthcare settings. While this list is by no means comprehensive, it reflects the goals adapted by the MHS and which strategies most

influence the diagnostic and surgical areas. Design considerations that impact patient health and improve hospital functions have been established through numerous studies⁴. A series of evidenced-based design strategies are highlighted to give a better understanding of their impact.

polytrauma patients



Given their **complex injuries**, polytrauma patients require blended diagnostic/surgical suites to be treated effectively.

Combined with **observation areas** allow students to learn first hand and families to be close to their loved ones.

blended diagnostic/surgical + observation

⁴ Gaeta et al., 2000

Spatial Orientation-

Using consistent and intuitively designed environmental graphics, ample fenestration and establishing internal landmarks such as water features help orient visitors. If done selectively they have a calming effect that reduces stress⁵.



(Courtesy of behance.net)

⁵ Joseph 2006

Foster Social Support-

Additional seating and family spaces within a hospital has become more common. The effect of a family's presence on a patient's healing process can be quite profound⁶. Many times this can be easily achieved by clustering furniture in small groups or dedicating space for families waiting to make key decisions for their loved ones.



⁶ Muething, Kotagal, Schoettker, Gonzalez del Ray, & DeWitt 2007; Sisterhen, Blaszkak, Woods, & Smith, 2007

Natural Lighting-

Natural light has proven to aid in the healing of patients and creating a less stressful hospital experience⁷. It's shown to decrease depression⁸ and reduce the length of hospital stays⁹. It also lessens pain¹⁰ and reduces agitation¹¹, all negative stimuli in the healing process. It does hinder thermal comfort control to a degree and that must be considered in the design process.



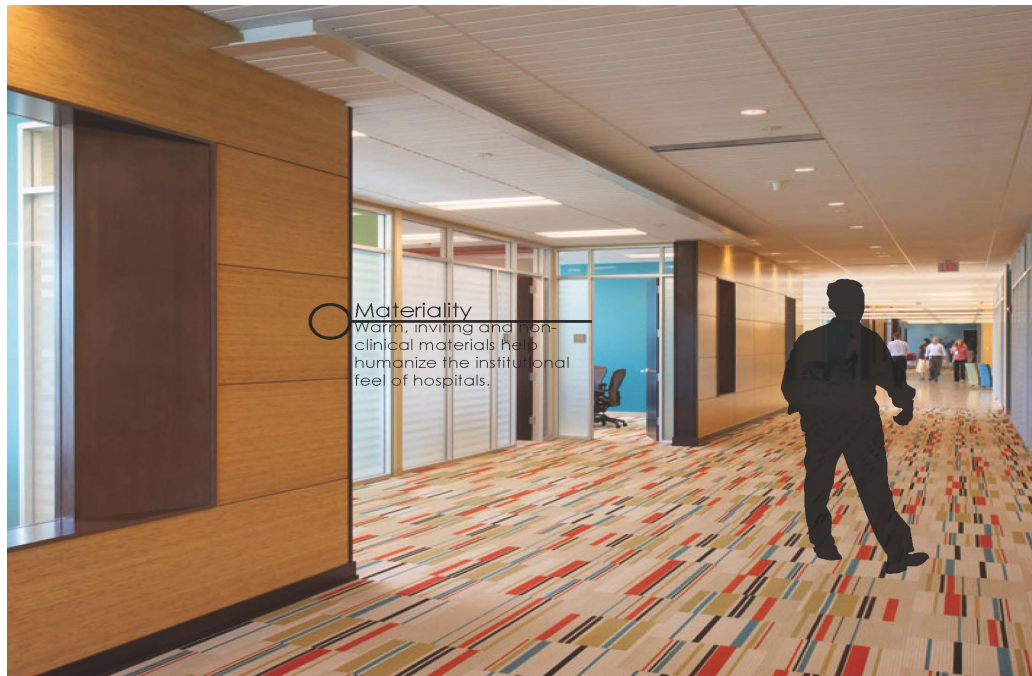
⁷ Walch, J. M., Rabin, B. S., Day, R., Williams, J. N., Choi, K., & Kang, J. D., 2005

⁸ Benedetti et al., 2001

⁹ Benedetti, Colombo, Barbini Campori & Smeraldi, 2001; Federman, Drebing, Boisvert & Penk, 2000; Beauchemin and Hays, 1996

¹⁰ Walch et al., 2005

¹¹ Lacgrace, 2002



Orient with Material Cues-

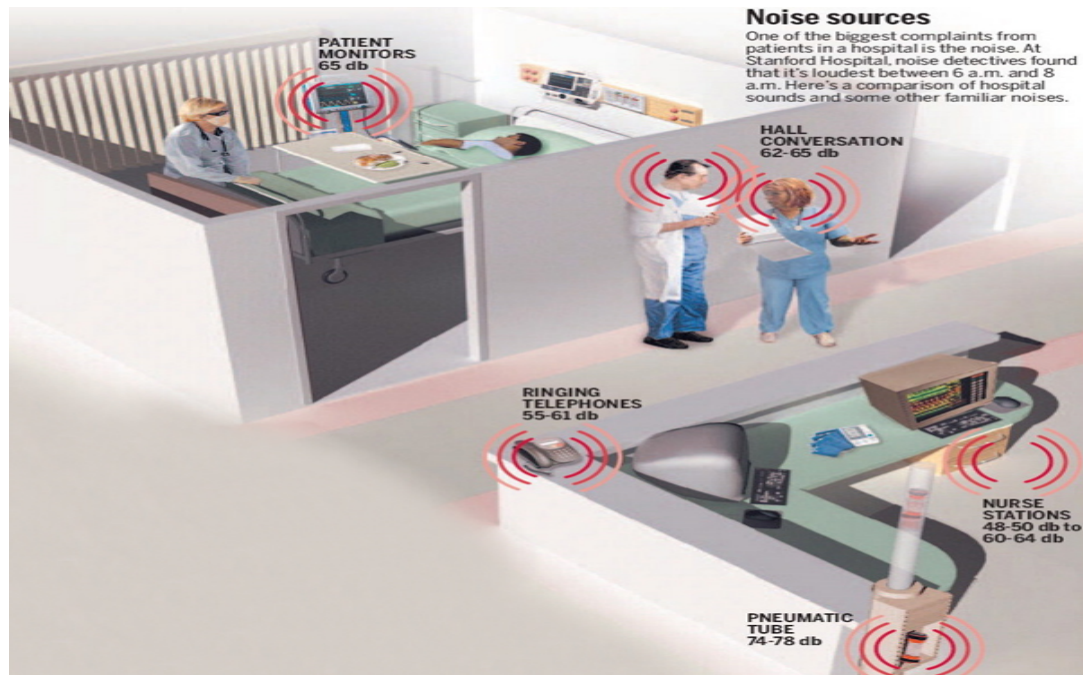
Changes in floor patterns/color/material can identify different areas and uses. For exam room prep areas, it can cue nurses or doctors to wash up before and after examinations¹². Also, cleanliness is paramount with anti-microbial and hygienic surfaces being ideal.

Consistent or Thematic Aesthetic-

To lessen the stress of being in an unfamiliar environment, establishing a consistent layering of colors¹³, materials and composition give a sense of place to a large complex. Designating a specific color or material type to specific area can make them easier to identify.

¹² Young, J., 2007.

¹³ Young, J., 2007



(Courtesy of mcinteractive.org)

Lessen Acoustic Stress-

The buzz from florescent lights, foot traffic and the sounds of medical equipment can reach over an average of 68 decibels or higher. Such high levels of noise can be mitigated with sound absorbing materials and reduce the impact of acoustic stress on staff and patients alike.¹⁴ Reducing noise has also been known to lower blood pressure, heart rate and reduce patient readmission¹⁵.

¹⁴ Joseph, 2006

¹⁵ Hagerman et al., 2005

Improve speech intelligibility by reduce noise-

When noise is reduced, people usually process their thoughts more effectively, decreasing medical errors by staff and patient anxiety¹⁶.



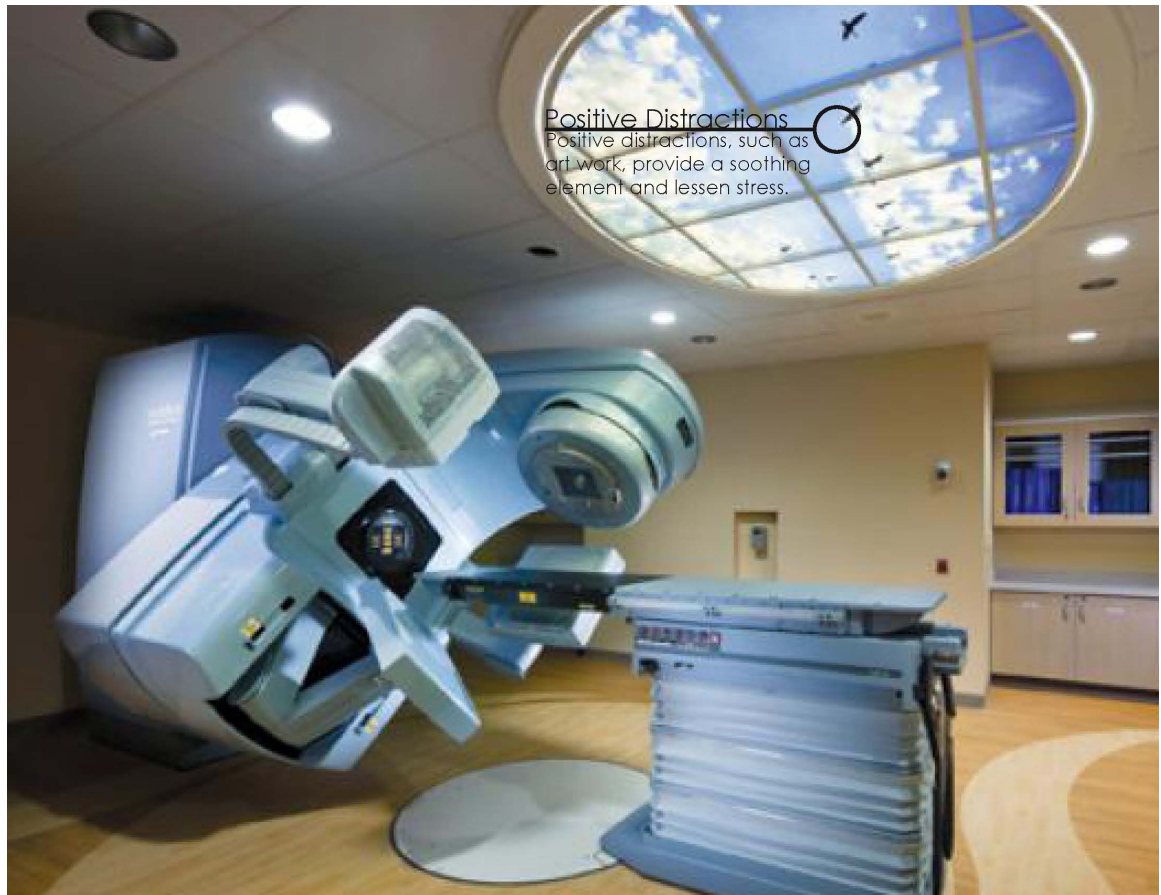
(Courtesy of HDR)

Air Filtration & Control-

Considered one of the most critical components for designing a healing environment¹⁷, air filtration, air control and thermal comfort considerations can substantially improve health outcomes.

¹⁶ Fick and Vance, 2008; Moeller, 2005

¹⁷ Malkin (1992, p.10)



Positive Distractions
Positive distractions, such as art work, provide a soothing element and lessen stress.

Positive Distractions-

Providing positive distractions, such as artwork, water features, garden, views to nature, and outdoor courtyard spaces helps mitigate stress, reduce pain and improve health outcomes as a result¹⁸.

¹⁸ Ulrich, 2008; Malenbaum, Keefe, Williams, Ulrich, & Somers, 2008; Ulrich, Zimring, Quan, & Joseph, 2006.

Explorations

Design Drivers

Synthesizing these abstract design principles into an interactive program and orchestrated by the architect's vision will bear a design relevant to the values of this thesis. This process can also be applicable to other aspects of the MHS and perhaps to a larger audience, as is the long-standing practice with military innovation influencing the public realm.

Surgical Suites/Operating Rooms-

These spaces require a certain set of adjacencies, including prep room for surgical staff, supply rooms, observation area (optional or combined), exit/entry area for patient bed. If you include a remote surgical device such as a Da Vinci Surgical System, the need for additional space and system connections needs to be taken into account. The minimum for most operating rooms is 400 square feet each and up to 950 square feet.

Diagnostics Department-

Large, shielded rooms with advanced electrical control for such things as a MRI or similar machines. They require an observation area for the monitoring equipment and technician as well as additional circulation and storage space. Since these rooms are typically buried deep in the building, access to update equipment is a consideration. In addition,

creating an environment that focuses or distracts the patient away from the otherwise clinical feel of a MRI or CT room. Increasingly, blending imaging/radiology/diagnostics with operating rooms has shown to be increasingly beneficial for staff effectiveness¹⁹ and health outcomes.

Internship: AECOM

To better equip myself to explore healthcare design, I'm sought out an internship at AECOM's Healthcare Studio in their National Capital Office in Arlington, VA. As much research as I did in evidence-based design and other relevant healthcare design ideas, gaining real world expertise was essential for thoroughly executing my thesis.

I primarily worked on a teaching hospital expansion and translational medicine research tower for Stony Brook University Medicine in NY. This was a 500,000 SF project comprised of two large 10-story towers connected to the existing Bertrand Goldberger-designed Health Sciences Complex. The Medicine & Research Translation Tower or MART as it was called, was a opportunity to delve into the Translational Medicine, which is in essence, is about fermenting innovation and ideas by cross-pollinating programing for researchers and practitioners. This is intended to create a faster pipeline from the research bench to the bedside by having these two "silo" groups spontaneously meet and interact.

¹⁹ Moore and Komras, 1993

internship experience
AECOM Healthcare Studio, Summer 2013



Stony Brook University Teaching Hospital +
Translation Medicine Expansion
Stony Brook, NY
Courtesy of AECOM+Pelli Clarke Pelli

Suburban Hospital
Expansion
Bethesda, MD
Courtesy of AECOM

My experience on another project, the Suburban Hospital Expansion in Bethesda, MD was also extremely helpful. Having to update surgical suite plans, their supporting spaces and medical surgical inpatient areas to reflect the most recent International Facilities Guide for Healthcare Facilities or IFG an informative exercise. The supporting spaces, such as the sterile storage, PACU, Step Down II Recovery and Patient release areas, among others, are all required to properly support surgical operations. These spaces are highly regulated in terms of their use, adjacency and construction. Flows of people, both patient and staff, as well as clean and soiled materials, such as laundry, medicine and other medical supplies have to be carefully considered. For my blended

operating suites, gaining that first hand medical planning experience was essential.

Thesis Design Studio:

site:

Walter Reed National Military Medical Center



Bethesda Naval Hospital, ca. 1940



After it's latest expansion in 2011, the base was renamed after the now closed Walter Reed Army Medical Center.

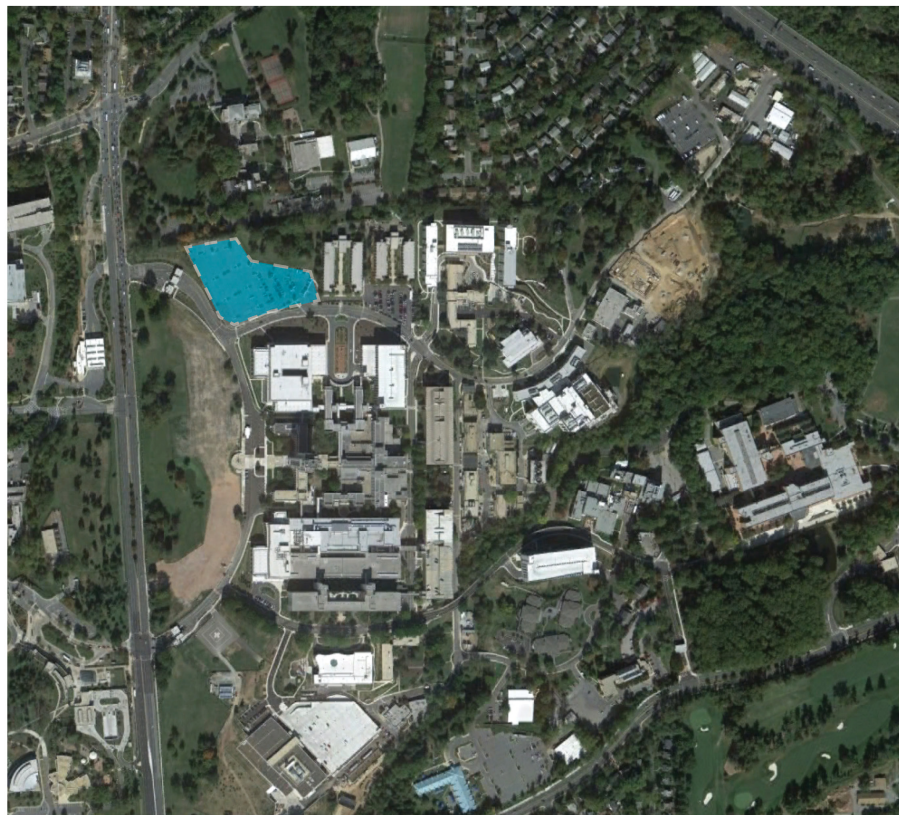


Site:

Walter Reed National Military Medical Center, located on the former site of the Bethesda Naval Hospital in Bethesda, Maryland was chosen as the site. It's recent expansion of state of the art inpatient and ambulatory facilities, it's flagship status in the Military Health System and proximity made it an ideal choice. Originally sketched by President Eleanor Roosevelt himself, the main tower and original wings were built in 1940 and it's glistening white, vertical surfaces have been a hallmark of

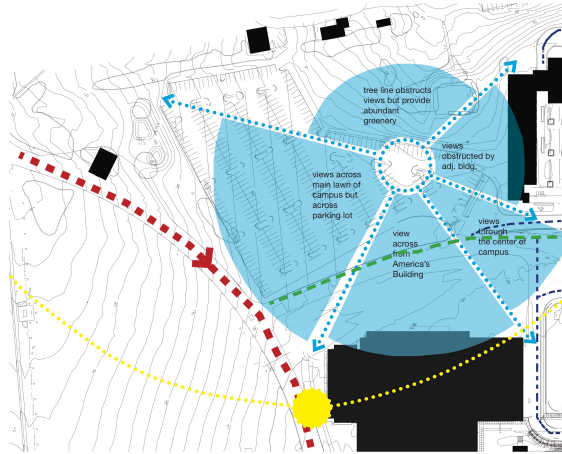
the area ever since. The repetitive cadence of vertical precast panels is reminiscent of soldier's marching across a parade field. It's classically Beaux Arts layout includes a vast green sward leading up to the centrally located tower. Given the program type, close proximity to the main facilities was required. The north parking lot fronting Rockville Pike seemed the most fertile area for expansion.

site





That lot, directly in front of the north entrance gatehouse, created a unique opportunity to add a visual punctuation mark for the entry to the campus proper. As well, since the site rose 20 feet above the gate entrance, it would have a presence from Rockville Pike and could help usher in visitors to the campus.



Program:

The program was dictated by identifying an area of need in the Military Health System, namely treating polytrauma wounded warriors by creating a facility places the right expertise, with the right support infrastructure in the right place. Instead of crisscrossing the country to obtain care, health outcomes can be improved by co locating services. Given the long downtime between surgeries this occasionally required, proximity to inpatient care is critical but given the scope of this thesis, the use of Walter Reed Bethesda's extensive on-campus facilities will be sufficient. That said, overlaying ideas of translational medicine, which promotes social interactions and therefor the exchange of ideas, ample social and public space is needed. Again, the location of the site at the north gate entrance is ideal, and can act as extend public entry realm for visitors. Extensive seating and lounge areas will be included in an enclosed courtyard, with café and eating areas to further attract foot traffic from around campus, further activating the space. These seating and lounges

will be intermingle with circulation paths, further encouraging interaction and creating a more energetic, multi-level atmosphere.

program:
medical+learning+public



pre-op
anesthesia
4 operating suites
clean core
PACU
Step Down II
patient release area
sterile storage
laundry
soiled storage
consulting rooms
work rooms
staff lounge
staff locker rooms

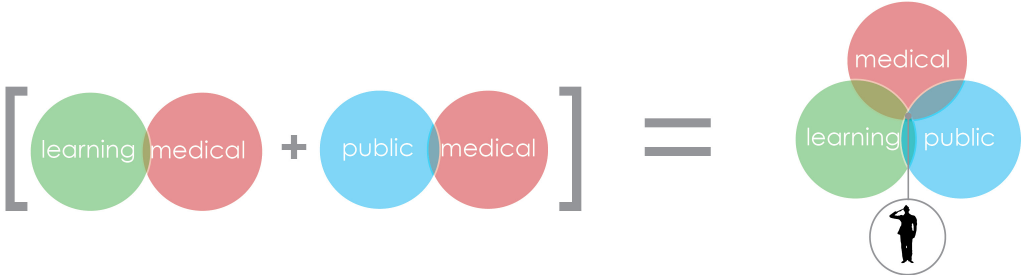


classrooms
observations wells
conference rooms
offices
auditorium
lounges

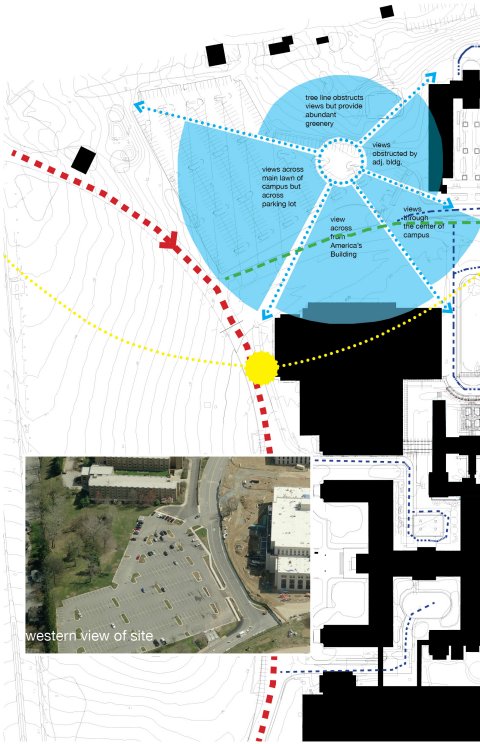


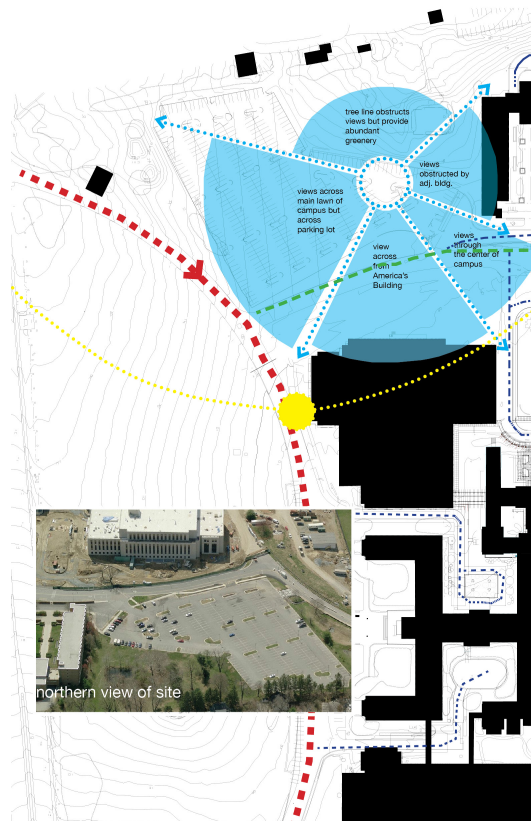
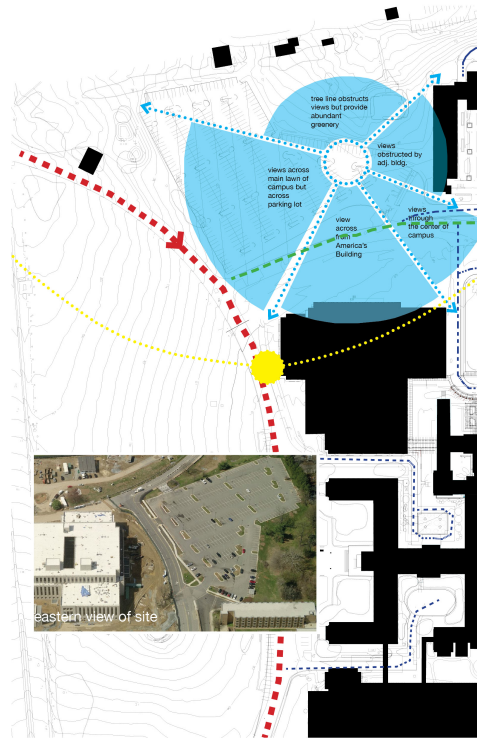
interior courtyard
cafe
lounges
green roof
lobby

program:
medical + learning + public



Evidence-Based Design x [Translational Medicine + Family-Centered Care]=polytrauma care





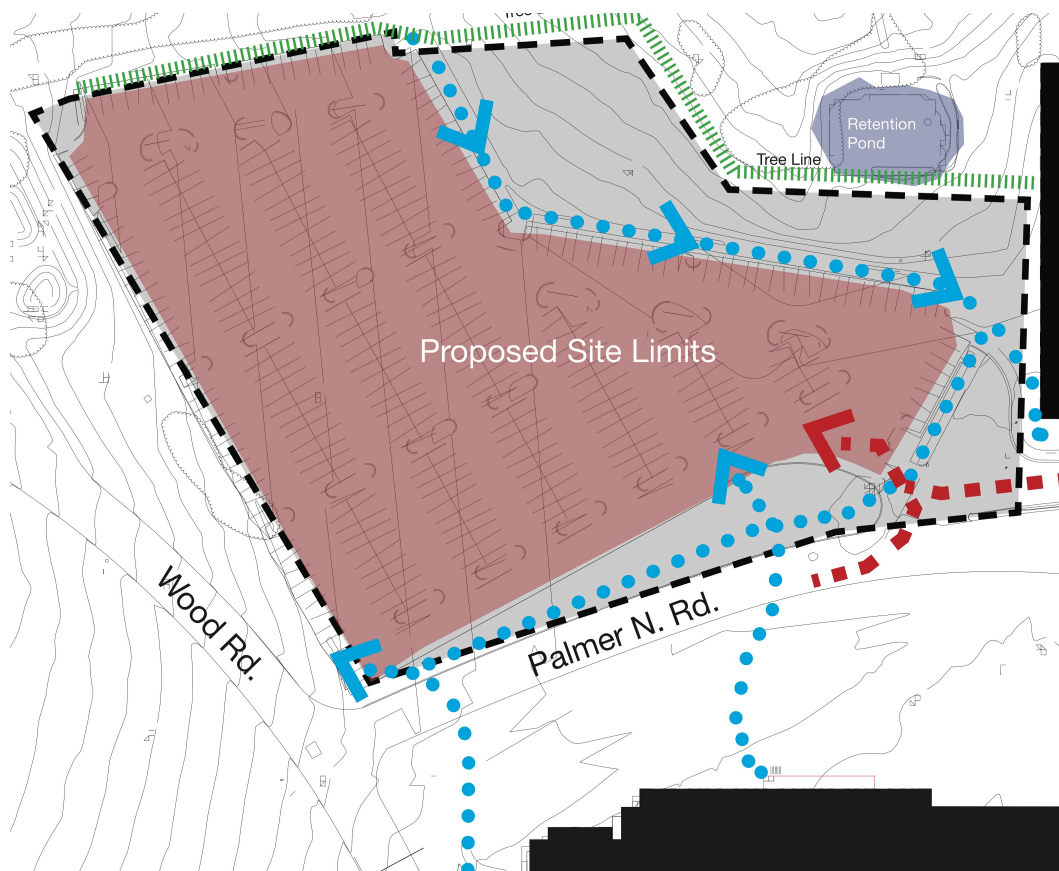
Massing:

Composed of three principle programs, medical, educational and public spaces, each is represented clearly volumetrically. To the north of the site, the large body of heavy medical programming is housed in a large 3-story bar of a building, with a heavy character about it. The bar also houses much of the mechanical systems required for a healthcare building. The arm of educational programming is a two-story affair, quietly submissive in size to the larger medical block to the north. It's lighter appearance curves to respond to the Beaux-Arts composition of the site, simultaneously respecting such geometry even as it's curving nature breaks the rectilinear composition of most other buildings at Walter Reed Bethesda. The 6-story tower acts as the pivot or joint of this massing composition, pulling together the medical block to the north and educational wing to south. It stretches towards the sky, with its southern side rising higher to create a terrace to the north and hiding the elevator penthouse. It acts as the visual punctuation mark to the campus from the north gate, responding the main campus tower to the south.

Circulation:

In addition the main entrance to the enclosed courtyard, numerous access points will grant access to outdoor areas, the green roof and to the rest of campus. Since the main building opens up to the campus on

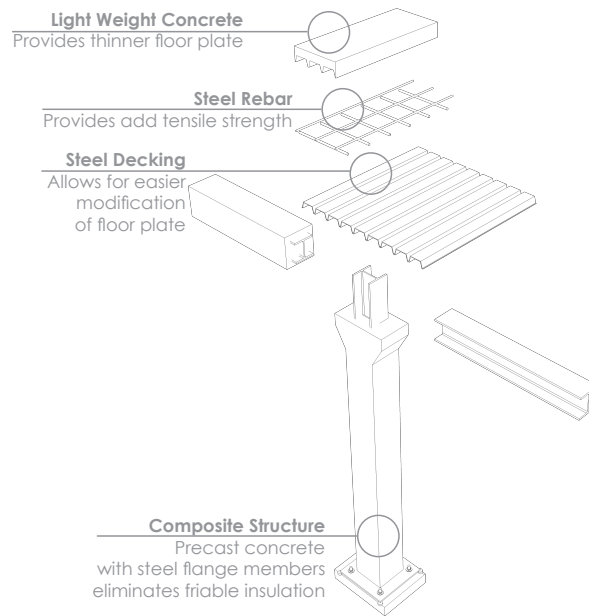
the eastern elevation, this will create welcoming approach from campus. In addition, the approach for visitors through the north gate will be marked by a gentle rise up the 20' hill, past a serene reflecting pond with waterfall. Once inside, either through the main courtyard or through the garage access in the basement level, circulation is multilevel. Numerous stairs of generous size encourage walking between classrooms and offices while public elevators are housed in the classroom tower, which includes ample double-height lobby spaces with additional seating. Within the restricted medial and educational areas of the building, there are internal stairs, both ceremonial and emergency stairs. A service elevator capable of handling a full trauma team is accessible from the garage as well.



Structure:

For the northern medical block, the structure is composed of a composite steel flange and precast member system. This is intended for several reasons, namely to deal with the heavier load of diagnostic and mechanical equipment and eliminate the need for friable fireproofing insulation that plagues future renovations with ICRA constraints. As well, the medical block enjoys a steel deck with lightweight reinforced concrete that allows for future modification that precast concrete units couldn't contend with. For the southern wing, since the loads are less severe a more conventional precast concrete system is employed with the same steel deck and lightweight reinforced concrete floor system. This holds true for the tower as well.

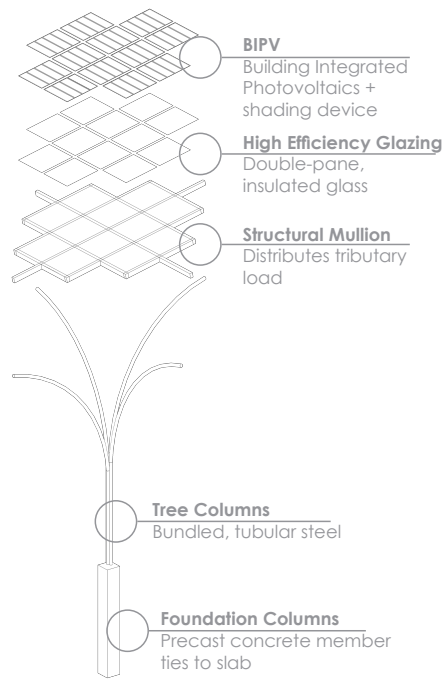
structure



composite precast structure

The third leg in the structural system includes the enclosed courtyard. In this public area, the intent was to contrast the heavy nature of the surrounding buildings with a light and airy feel. This is accomplished by a thinner, tubular steel forest of structural columns that curve up to meet the sloped glass roof of the enclosed courtyard. Each structural tree, as it were, is intended to breakup the vast open space, generate a series of outdoor rooms with varied seating arrangements, brings ample light deep into the building and creates a visual contrast to heavier, glistening precast facades of the building.

structure

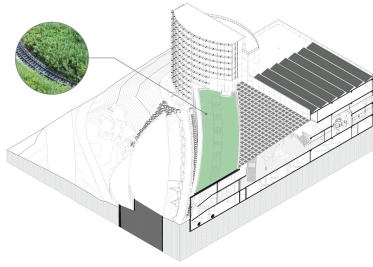


tree columns

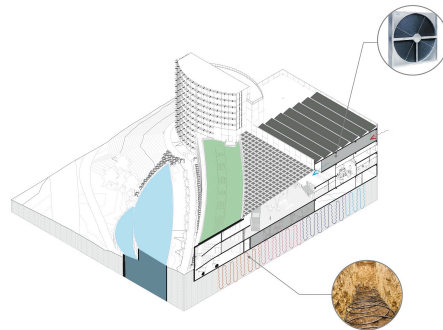
Sustainability:

While Walter Reed Bethesda enjoys several campus wide systems that the building can benefit from, such as heating, cooling and water treatment, designing as sustainably as possible only reinforces the ideals of the thesis. By creating a building as self-sufficient as possible, that nurtures itself, it reflects the healing environments within.

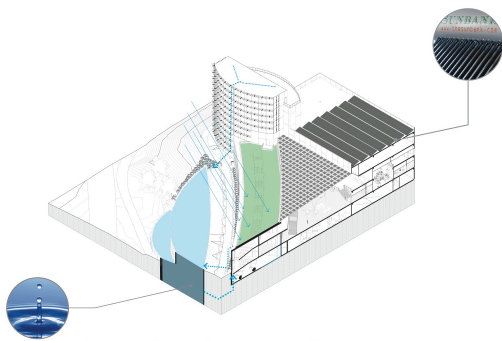
systems/sustainability



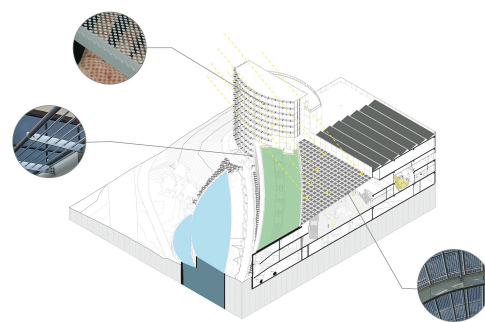
nature: walkable green roof + insulates southern wing



mechanical: geothermal + thermal wheel



water: onsite collection/filtration + solar water heating



solar: building integrated PVs + shading from southern exposure

Energy-

That said, creating it's own energy is first and foremost. Building Integrated Photovoltaic or BIPVs will give further purpose to the double glazed glass roof, which is sloped south for maximum exposure. Besides providing energy, it further shades the enclosed courtyard.

Mechanical-

As well, given the large heating and cooling load required for healthcare buildings, the use of geothermal wells adds further efficiency to the mechanical system. By using the insulating nature of the earth to stabilize the internal temperature of the building, less energy is required to

heat or cool air. The addition of a thermal wheel further enhances these systems, exchanging the heat from expelled air to warm up cooler incoming air.

Water-

In regards to water consumption, the use of low flow fixtures only makes up a small measure of a sustainable approach. The reflecting pond along the southern slope of the site helps further by processing gray water collected from the green roof and the rest of the site. This gray water will be used first and foremost for toilets, irrigation and other non-potable uses. As well, solar water heaters located on the vast north roof further diminish the need for inefficient hot water heaters that would otherwise supply the building. Exploring their use in the mechanical system could lead to further efficiencies.

Materials-

Given the glistening, precast concrete panels of much of the campus, this building is no exemption. Though these precast panels will include recycled content and have much greater insulating capabilities. They'll also reflect much of the sun they receive, given their high albedo rating.

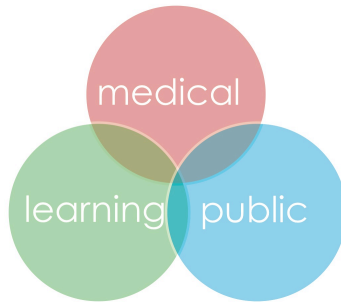
The glass facades will be low-e rated double glazed units with argon gas insulation. The sloped glass roof of the enclosed courtyard, as mentioned before, will incorporate BIPV's, which can shade as well as

produce energy. The glass tower will incorporate horizontal louvers on its southern face to further diminish heat gain. As much of the mechanical rooms and elevators back the southern elevation, solar heat gain will be further diminished. The east and west facades of the tower will incorporate vertical louvers to cast shadows.

The roofing material will incorporate high albedo materials and reflect solar heat gain as a result. The green roof will create an insulated layer atop the southern wing, which lacks the mechanical level to act as a buffer from solar heat gain that the northern block enjoys. It will also be an added amenity to the third floor, reinforcing the evidence-based research the building is informed by. The green roof also holds the potential to hosting water processing reed beds but that is aspect of the design that still needs to be explored further.

Final Design:

design approach

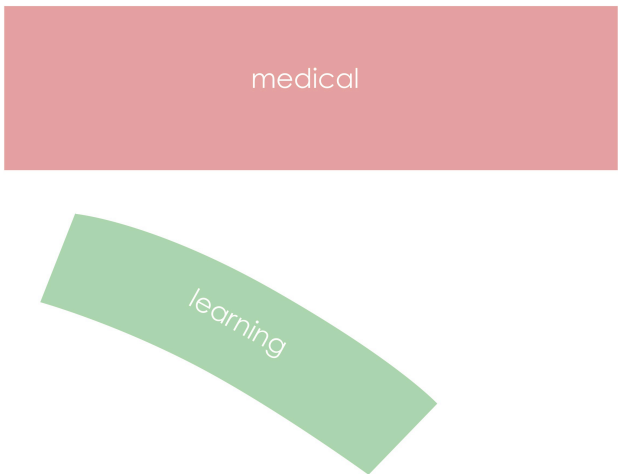


design approach



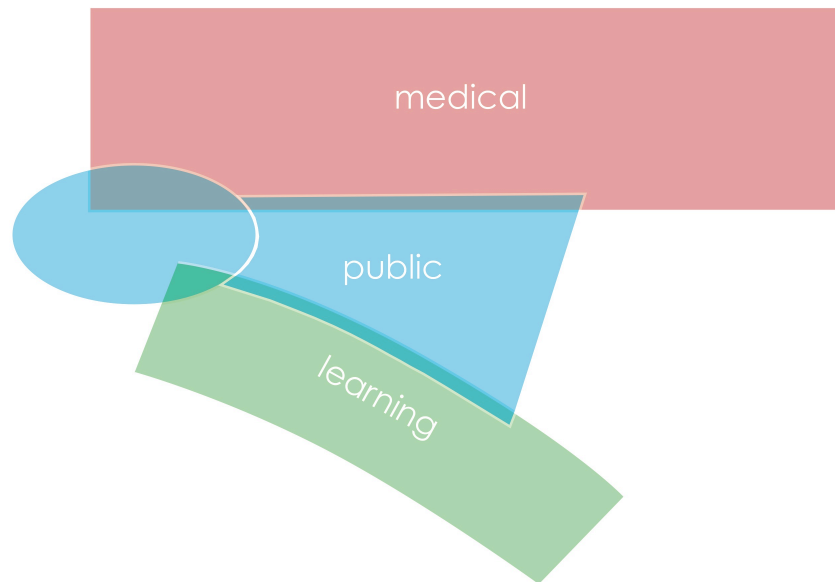
body of medical program: linear patient pathway

design approach



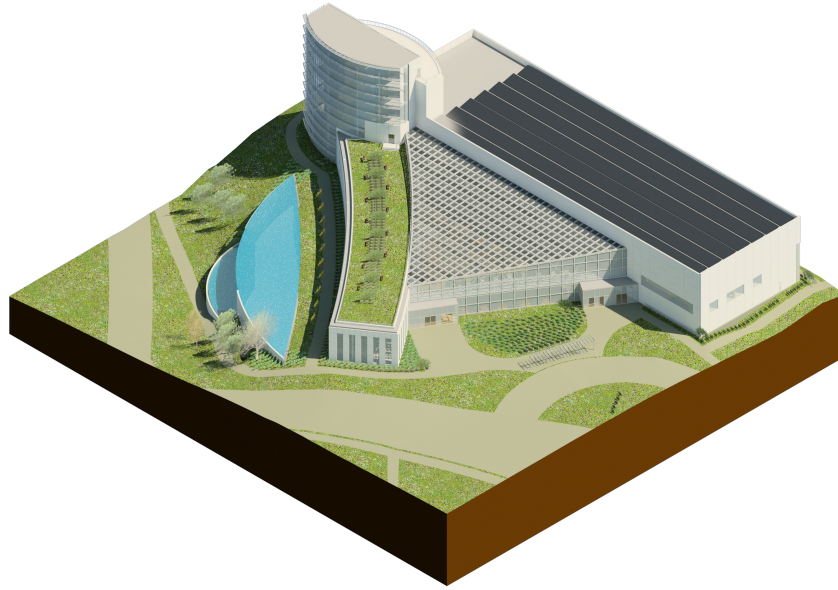
arm of learning program: curves to respond to campus context

design approach

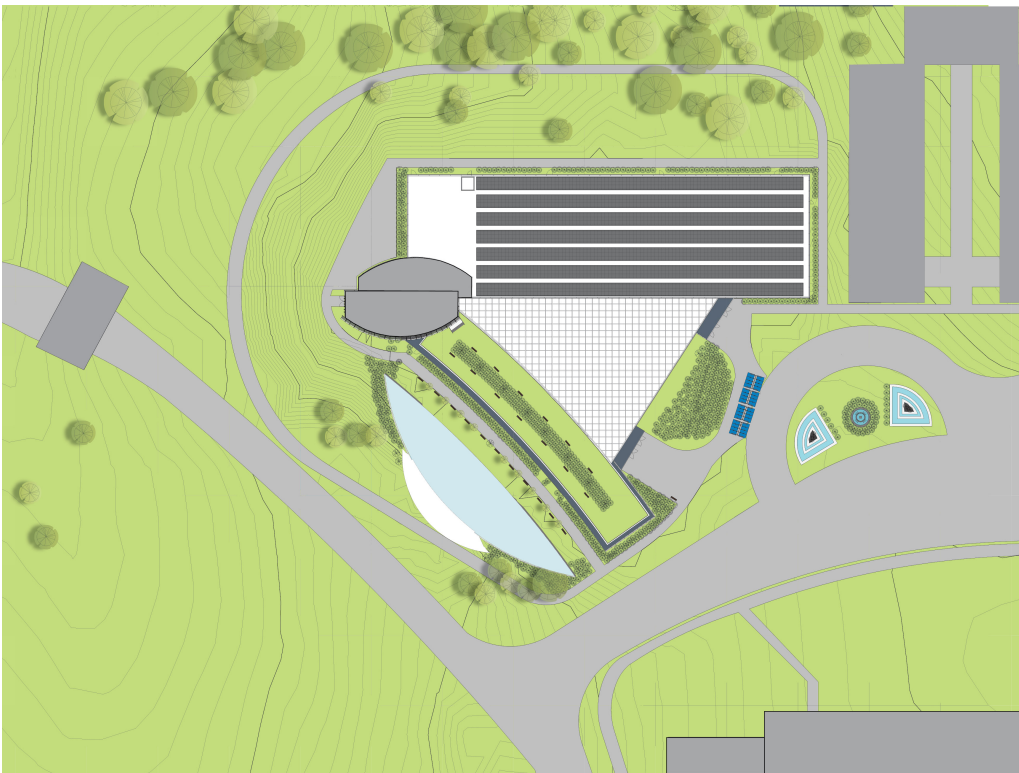


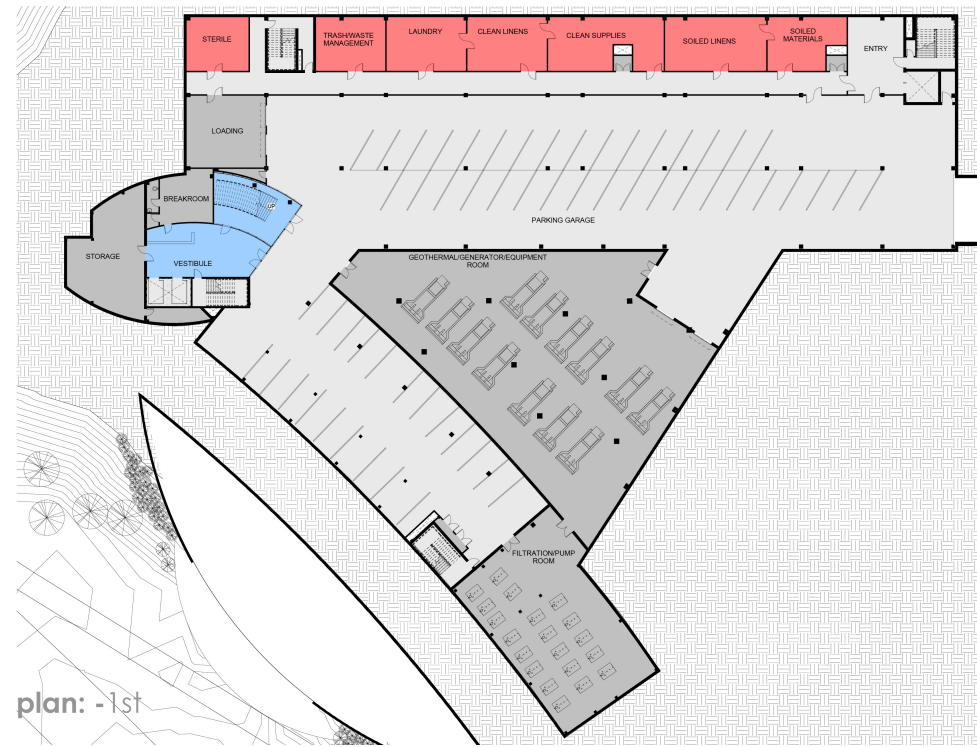
public spaces ties them together: invites campus in

design



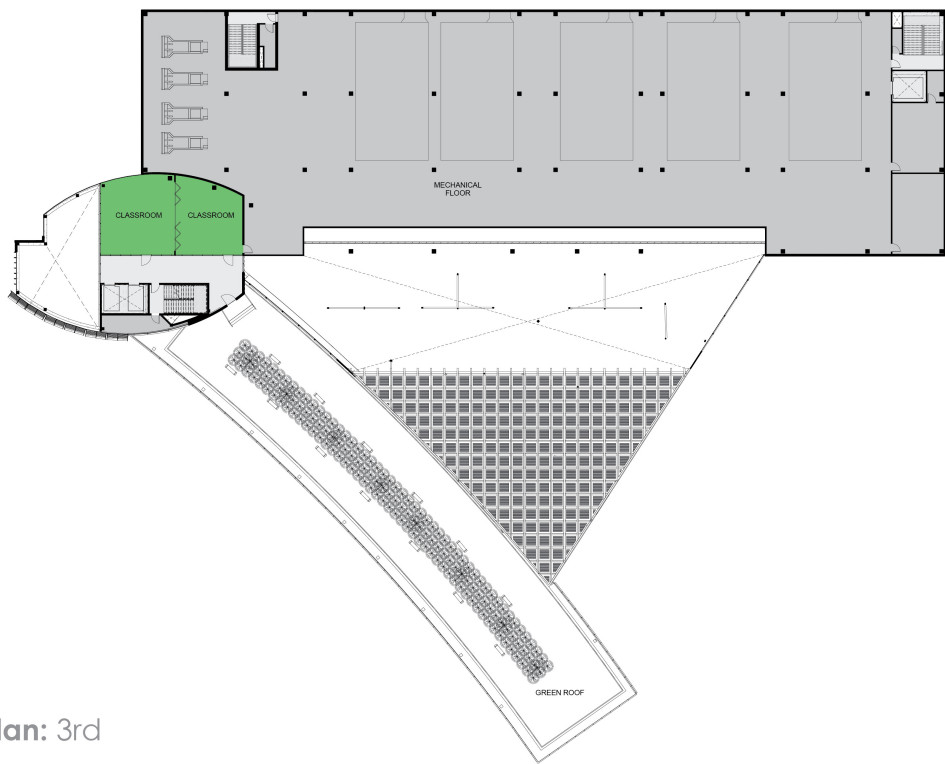
birdseye: southeast







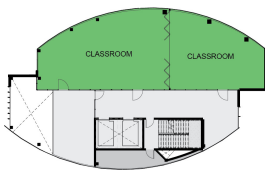
plan: 2nd



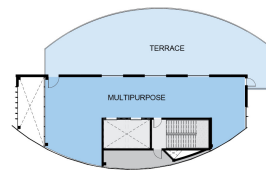
plan: 3rd



plan: 4th



plan: 5th

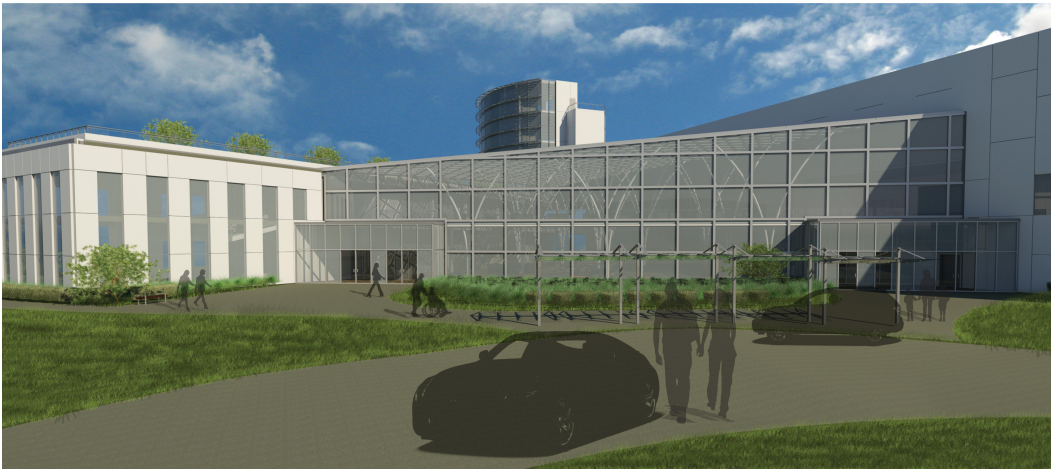


plan: 6th

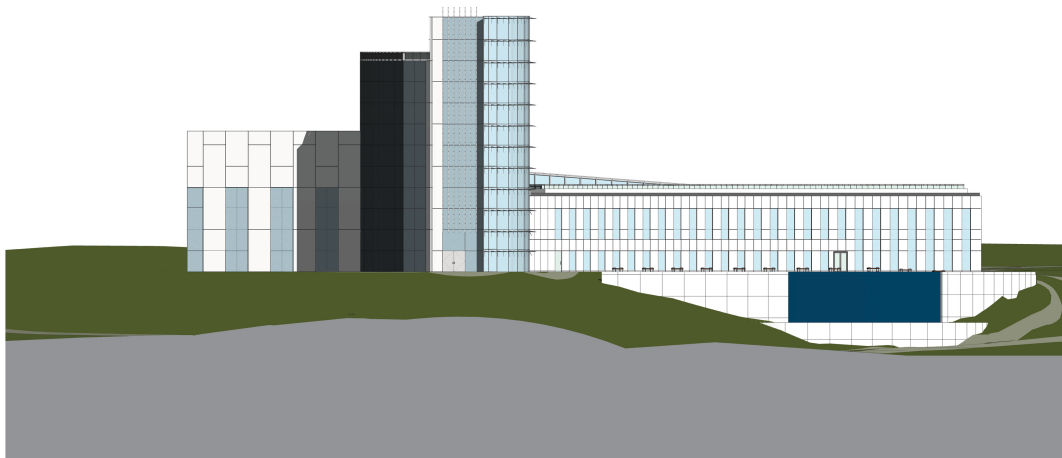




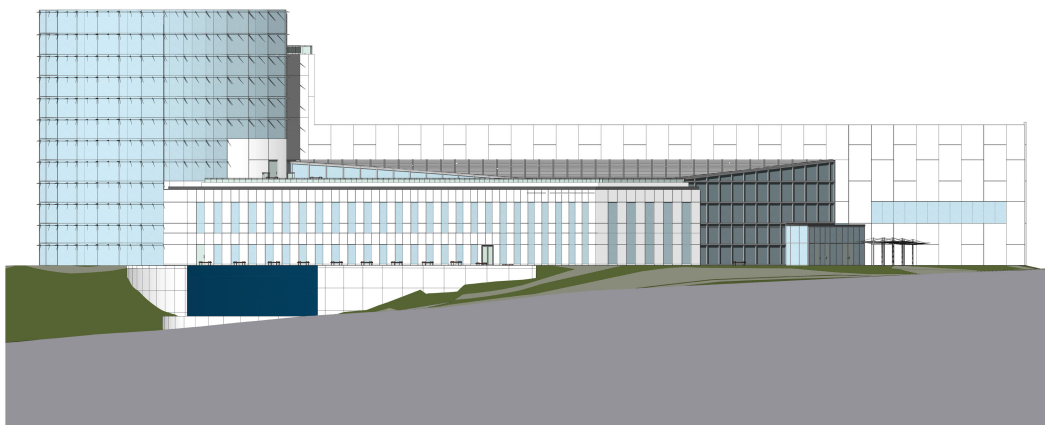
south east



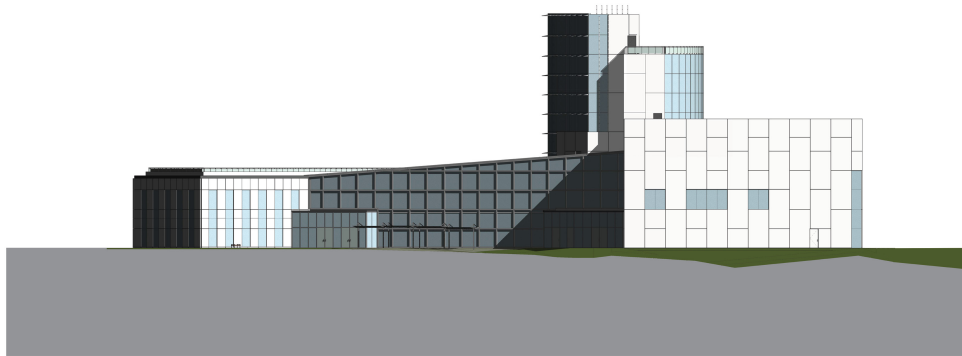
campus approach



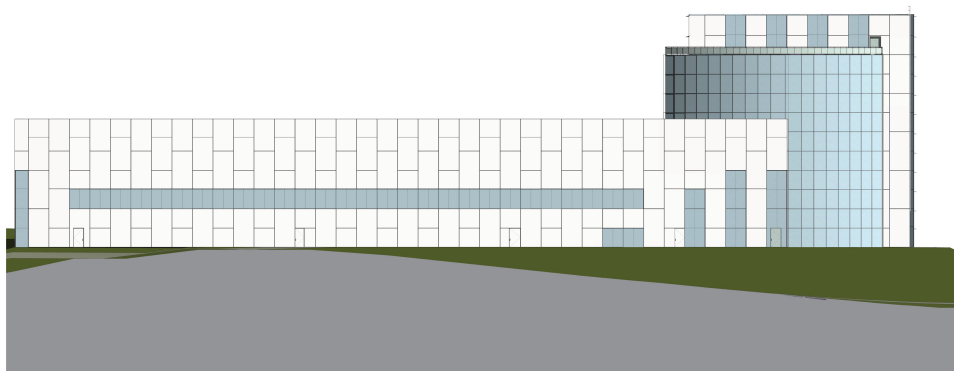
elevation: west (north gate approach)



elevation: south (along drive)



elevation: east (from campus)



elevation: north



interior: courtyard entry



interior: courtyard southern view



interior: courtyard view east



interior: lobby

Conclusion:

As outlined in the thesis research, the aim of this thesis is to create a design model that is applicable to future military medical installations across the country. That impetus gives greater relevance to our profession and the role of the architect to ensure the **health** of our wounded warriors, the **welfare** of their families and to **foster** knowledge of polytrauma care for future generations. Applying that knowledge within the Military Health System will better sustain the *built environment*, improve *healing spaces* and heal *wounded warriors*.

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